

INVESTIGATOR'S ANNUAL REPORT

National Park Service

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Reporting Year: 1999	Park: Shenandoah NP
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Permit#: SHEN1999N-192	
Park-assigned Study Id. #: unknown	
Project Title: Implications Of Catchment Structure For Time-Varying Hydrological And Hydrochemical Response In A Forested Headwater Catchment	
Permit Start Date: Jan 01, 1999	Permit Expiration Date Jan 01, 2000
Study Start Date: Jan 01, 1997	Study End Date Jan 01, 2002
Study Status: Completed	
Activity Type: Research	
Subject/Discipline: Water / Hydrology	
Objectives: <p>Catchment structure, including both surface topography and subsurface permeability structure, is an important determinant of the hydrological response of a catchment to precipitation events. Stream water chemistry is in turn influenced by time-varying flow paths through the catchment. Although much progress has been made in recent years in understanding the flow paths through catchments and how chemical composition of waters reflect these paths, the impact of different simplifying assumptions underlying current models have not been explored systematically. The goal of the proposed study is to develop a quantitative and predictive physically-based model of the hydrological response of a saprolite-granite catchment and to explore the importance of surface topography and subsurface structure in determining key aspects of catchment hydrochemical response. Our study site is the 237-hectare catchment drained by the South Fork Brokenback Run (SFBR), on the north side of Old Rag Mountain, Shenandoah National Park, Virginia. A soil and saprolite regolith is developed on top of the Precambrian Old Rag granite that underlies the entire catchment. Observations made over the past three years at this site have motivated the proposed study: a transient perched water zone contributes stormflow to the stream; stream silica concentrations display a hysteretic concentration-discharge trajectory during storm events; silica concentrations in soil water display very little temporal variation, but tend to increase downslope; significant aqueous concentrations of silica, which vary systematically with depth, are reached within days after water contact with the rock. The objectives of the proposed study are to:</p> <ul style="list-style-type: none"> o Develop a theoretical framework for quantifying transient, topographically-controlled water movement and chemical transport in the subsurface; o Examine model sensitivity to hydrological and geochemical parameters; determine critical controls on concentration-discharge (c-Q) dynamics; o Test this theoretical framework using a combination of hydrometric and tracer observations. <p>Quantitative analysis of coupled hydrological-geochemical processes in catchments is necessary to resolve important questions about biogeochemical transformations that impact water quality. The proposed studies will lead to a deeper knowledge of how catchment structure controls patterns of hydrochemical response.</p>	
Findings and Status: <p>We have evidence that stream dynamics reflect a system composed of an ephemeral subsurface stormflow zone perched above a regional water table. In particular, the relationship between dissolved silica and stream discharge "loops" (i.e., exhibits what is often termed hysteresis in the c-Q relationship) in the clockwise direction. The impacts of different simplifying assumptions for describing the transport of silica through catchments were investigated. A</p>	

modified version of TOPMODEL was implemented which included both a shallow stormflow zone and a deep groundwater zone. The positive correlation observed between the average groundwater saturation deficit calculated with TOPMODEL and baseflow dissolved silica concentrations was consistent with results from batch leaching experiments and petrographic analyses of regolith core samples. The direction of modelled c-Q loops was inconsistent with observations, however, when a fixed end-member concentration was used for the stormflow zone. This suggests that mixing in the stormflow zone may be important, at least under certain conditions. The impact of mixing was investigated by examining the possibility that temporal variation in soil-water concentrations of silica can explain how clockwise hysteresis loops in the c-Q curve can arise. In particular, the role of the ratio of a hydrological time scale to a chemical time scale in determining the nature of hysteresis loops is examined. Our results suggest that the nature of the observed loops in c-Q curves for silica in small catchments that have a mechanism whereby water flowing through shallow soils can move rapidly to the stream, may be determined by a ratio of a hydrological time scale to a leaching time scale.

For this study, were one or more specimens collected and removed from the park but not destroyed during analyses?

No

Funding provided this reporting year by NPS:

0

Funding provided this reporting year by other sources:

70000

Fill out the following ONLY IF the National Park Service supported this project in this reporting year by providing money to a university or college

Full name of college or university:

n/a

Annual funding provided by NPS to university or college this reporting year:

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